



PROCEEDINGS OF THE 2nd INTERNATIONAL VEGETATION USER CONFERENCE

**1998 - 2004:
6 YEARS OF OPERATIONAL ACTIVITIES**

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FORESEEN: A FOREST AND REMOTE SENSING EXCHANGES NETWORK

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ABSTRACT

The Guiana Shield in South America is one of the largest wild areas in the world. However, this area is currently facing unsustainable logging, poor and often illegal mining practices and agricultural activities. This paper presents a project aiming at: promoting capacity building and training of people from this area in remote sensing; preparing a vegetation map using low resolution data; and develop tools to estimate the impact of human activities on the forest using high resolution satellite imagery. The building of a network of trained experts in remote sensing is devoted to complete these objectives.

1. INTRODUCTION

This paper presents a project aiming at building a network of remote sensing experts focused on land cover mapping. The study area is located in the Northern part of South America. This region remains today one of the Earth's last places where it is still possible to plan for economic development and maintenance of a healthy ecosystem for the long term. Unfortunately the area faces unsustainable logging, poor mining practices, and hydroelectric projects which have already altered pristine areas. The Guiana Shield Initiative [1] is a program focusing on planning a long term sustainable future for the region. The idea of the Foreseen project arose from this initiative. The objective is to better understand the spatial distribution of the ecosystems (forest, swamp, savannah and agriculture) and to locate and quantify human impacts. Remote sensing is the ideal tool used to reach these objectives since it allows to gather information on large, inaccessible areas, at a reasonable cost and in harmonized way. The main expected results are : (1) capacity building, training of people from different countries of the Guiana Shield on the use of remote sensing techniques. These people should work in the network in order to share experiences and solutions to their common problems ; (2) publication of a vegetation map of the Guiana Shield ; (3) publication of a map of the human impacts of the Guiana Shield.

2. MATERIAL and METHOD

2.1 Study area

The Guiana Shield (GS) of South America stands as one of the world's last great wild places. It covers the northeastern third of Amazonia (Fig. 1), an area of 2.5 million km², all of Suriname and Guiana, all of the French department of French Guiana, all of Venezuela south of the Orinoco (Amazonas, Bolivar and Delta Amacuro states), southeastern Colombia between the Guaviare and the Caqueta Rivers, and all of Amapa and Roraima in Brazil and the northern portions of the states of Amazonas and Para.

The region accounts for more than 25% of the world's remaining tropical rain forests. The Shield is one of the

oldest geological formations which include the sandstone Tepuis (Table Mountains) of the Guayana Highlands and unique vegetation such as the white sand vegetation (adapted to low nutrient conditions), savannas, extensive coastal swamp forests, riparian flooded forests, and several different tropical rain forest systems.

The Guiana Shield is one of the richest area with species diversity on Earth (over 20,000 vascular plant species for example).

The Guiana Shield region may account for as much as 10-15% of the world's freshwater. The human population density is 0.6 – 0.8 people/km².

2.2 Remote sensing imagery

Two datasets should be used within the network. First low resolution imagery such issued by the SPOT-4 /VEGETATION instrument will be useful to prepare the vegetation map of the Guiana Shield. We plan to use the Global Land Cover 2000 initiative dataset [2].

A 1-km resolution data which have been acquired on a daily basis during the year 2000. These data are calibrated, atmospherically corrected and geo-rectified. This dataset covers the entire area of the study (from 48° to 68° West and from 11°North to 4°South).

On the other hand, the use of high resolution imagery is necessary to perform the validation [3] but also to complete the second goal of the project, the human impact mapping. SPOT-HRVIR or LANDSAT ETM+ imagery will be used.

These images are accessible from space agencies or universities [4].

Different images were used from 1999 to 2004 in order to experiment the detection of human impacts such as roads, gold mining sites, agriculture and logging.

Future acquisitions should be done directly in Cayenne by the implantation of a SPOT-HRVIR reception station (planned for 2005).

3. EXPECTED RESULTS

3.1 Capacity building and Training

Once the monitoring priorities have been established the group will need agreement among the participating network members on a methodology for high resolution mapping and necessary training to do this mapping. This step will develop a network of qualified map makers working with the same methodology – in order to produce high resolution maps of the Guiana Shield.

At the May 2003 GSI Monitoring meeting in Belém [10] there was expressed interest among members in learning about both the methodology currently being used to map the Para state Midlands using LANDSAT, and to map the Eastern part of the Guiana Shield.

It is planned that at least each participating Guiana Shield nation would have at least one person trained within the network, and that over time an increase in network monitoring would contribute to growth and development in this area.

3.2 Prepare a vegetation Map of the Guiana Shield

Characterizing vegetation types in the Guiana Shield is of major importance for landscape analysis, considering land use change and forestry issues.

Recent Latin America land cover map shows the Guiana Shield as a large homogeneous green area [5].

The plan is to analyze through the dataset how the diversity of the forest could be identified. Using algorithms developed previously [6] a first map on the Eastern part was proposed [7].

A distinctive gradient from the coast to the inner part of the Shield was already noticeable (Fig. 2).

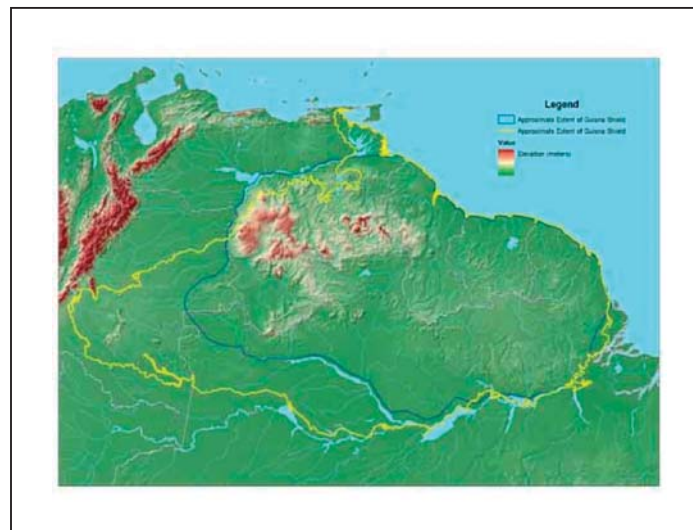


Fig. 1: Map of Guiana Shield region as defined at The Guayana Shield Conservation Priority Setting Workshop. The region as defined in biogeographic terms is bordered at South East by the Amazonas River, the South West by the JapuraCaqueta River, the West by the Serrania de Chiribiquete in Colombian Amazonia, the North West by the Guaviare and the Orinoco Rivers, the East and North East by the Atlantic Ocean

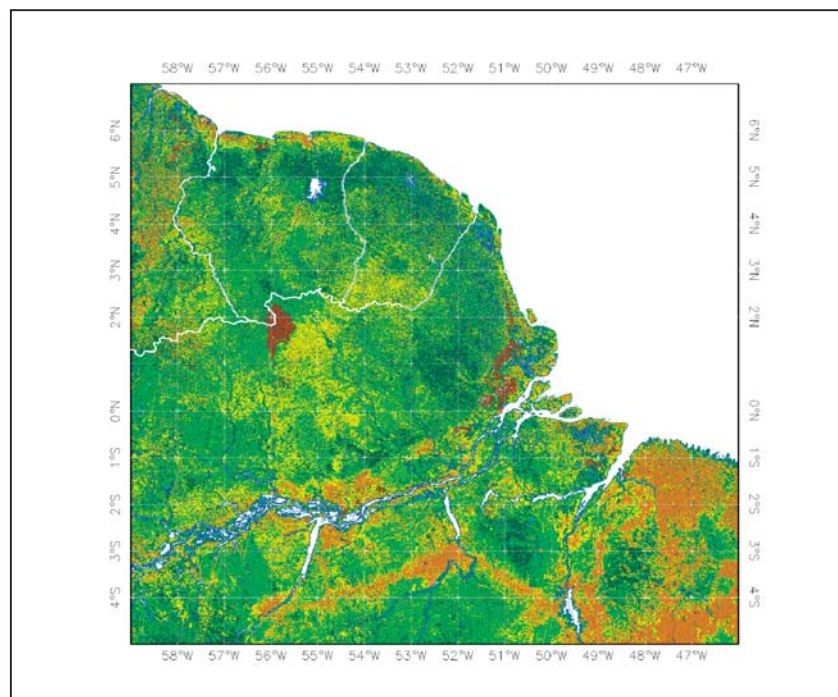


Fig. 2: A first step of research in the vegetation mapping of the Guiana Shield. Green colors and yellow are forested area (from humid to dry), orange is agriculture, brown is savannah and blue colors are swamp

3.3 Estimate human footprint on priority areas in the Guiana Shield

Mapping methods are used to produce maps that will quantify deforestation, estimate the area affected by logging and map existing roads [8]. Almost cloud-free (<10% cloud cover) LANDSAT TM/ETM images are used for time duration 1985-1990, 1991-1995, 1996-most recent. When cloud covered images impede the study of regular intervals, a mosaic of scenes is prepared and land cover change statistics are calculated for each scene. Field data are utilized to validate the image classification. All scenes are individually processed and geo-refer-

renced to UTM. A digital classification is done to extract deforestation, forests and water. A mixed pixel model is used to estimate areas of bare soil - whereby timber harvest trails, storage sites and roads are easily identified. The products are digital maps for each LANDSAT scene showing forests, water, logged forest and deforested areas which include pasture, plantation and secondary forest, forest road and tracks.

Human impacts mapping from high resolution remotely sensed data will be performed using SPOT-HRVIR and LANDSAT ETM+ sensors [9]. Algorithms and methodologies were developed to extract logging tracks, canopy gaps (Fig. 3), and gold mining activities (Fig. 4). All human activities which interfere with the canopy equilibrium can be detected. With simple methods it is now possible to map, in an automatic manner, this information and to provide geo-referenced data to a Geographic Information System. Using official data it is then possible to determine legal or illegal activities and estimate the anthropogenic impact on the natural environment.

The Guiana Shield forests are suffering from the impacts of gold mining and logging, with new trails, roads and deforestation. These activities are difficult to detect unless using high resolution remotely sensed data. The use of remote sensing is crucial because impacts begin as scattered, difficult to detect small-size events that go easily undetected. Such data incorporated into a Geographic Information System will then help to monitor the footprint. Annual updates will efficiently monitor human activity and provide a true service to government, non-government and private industry on legal and fully compliant economic activities, or otherwise.

4. CONCLUSION

The purpose of the FORESEEN project is to build a remote sensing experts network for the Guiana Shield. The objective is to train local people from the Guianas in the use of remote sensing techniques and to promote the exchange of experiences between partners. These people will then be able to develop a vegetation map for their country, using local botanical experts for validation. They will also be able to map the impacts of human activities in their respective countries. The combination of these two maps will result in an excellent tool that will help decision makers of each country in matters of landscape planning, including the identification of priority conservation areas, and of dealing with illegal activities.

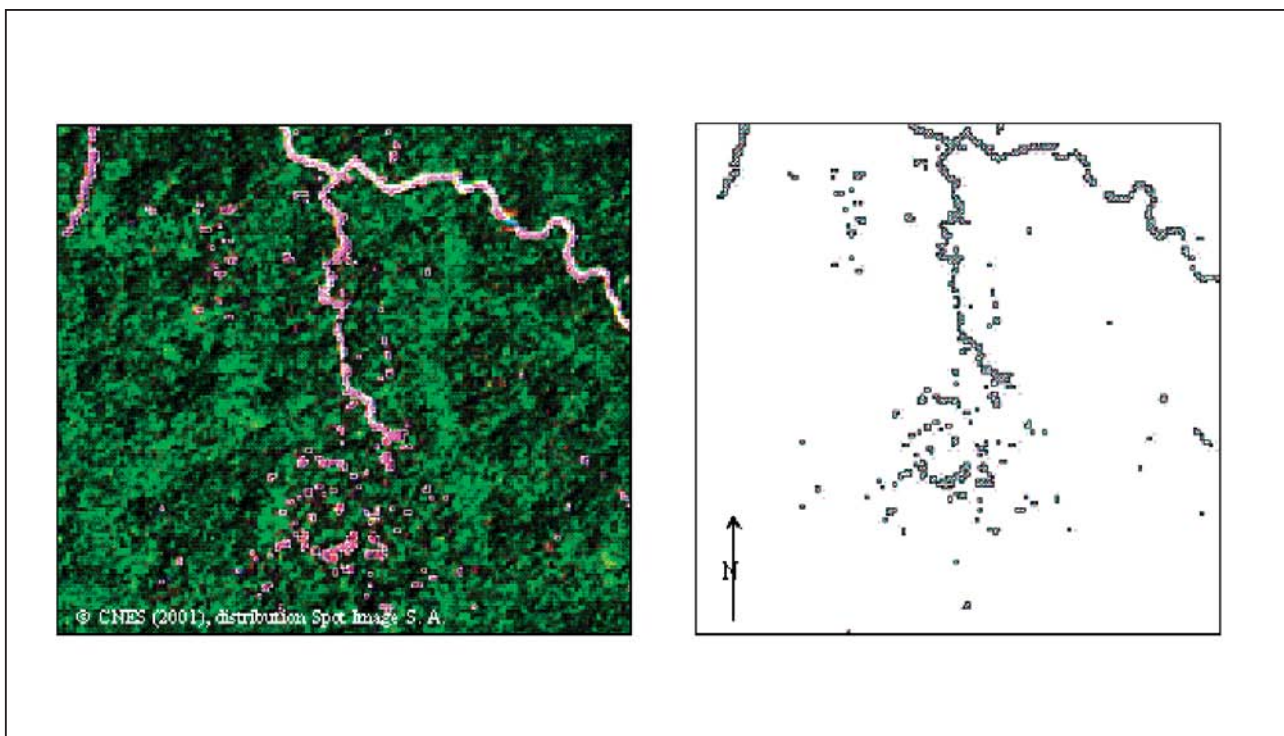


Fig. 3: Logging creates large gaps in the canopy. A method was developed to estimate the openness of the gaps. Data could then be extracted to provide information to a GIS. It is useful to plan and manage forest concession to identify illegal or abusive exploitation

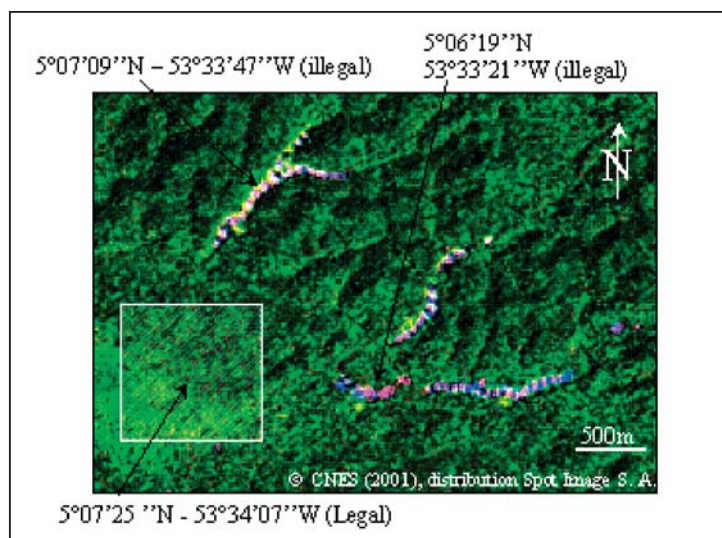


Fig. 4: Mining and more specifically alluvial gold mining activities are a real problem in the Guiana Shield. Here remote sensing provides a powerful tool to locate gold mining sites. A quick check of the legal concession (the white 1-km square) inform us about the location of illegal surrounding activities. As for logging the mining can be extracted (vector file) and incorporated into a GIS

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